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ABSTRACT

The minimal comprehension principle asserts that the act of comprehension must entail an interaction between an incoming linguistic message and the reader's world knowledge. An analysis of current tests of reading comprehension indicates that test passages are likely to draw broadly from knowledge of the world, so that some of the variability in test performance must be attributable to differences in prior knowledge rather than to differences in reading skills. Most tests of reading comprehension currently in use do not distinguish between these two sources of variability. This does not affect their usefulness as predictive instruments but greatly restricts the use of the tests for diagnosis of reading difficulties or assessment of educational gains. Optimal tests for these purposes would reduce variability due to prior knowledge or reasoning ability. Various suggestions for achieving this control are in need of empirical verification. (AA)

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CENTER FOR THE STUDY OF READING

Technical Report No. 91

ON THE THEORY AND MEASUREMENT OF READING COMPREHENSION

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Whenever we have had what we thought was a good idea about reading comprehension, we've generally found that John Carroll has had it first. He may not agree with what we have said, but he has influenced our thinking enormously. We would like to thank Jim Pichert, Al Moe, Glenn Kleiman, Joe Jenkins, and Nancy Stein for their comments on earlier drafts of this paper. They deserve much credit for anything of merit to be found in the paper. This paper was written while the first author was on leave at the Center for the Study of Reading, University of Illinois. The Center is supported by the National Institute of Education under Contract No. US-NIE-C-400-76-0116.

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On the Theory and Measurement of Reading Comprehension

The purpose of this paper is to review recent developments in the theory of comprehension and to derive implications from this work for the measurement of reading comprehension. Many recent commentaries on the topic of comprehension (e.g., Otto, 1971; Simons, 1971; Stauffer, 1971; R. L. Thorndike, 1973-1974; Tuinman, 1971) have lamented the fact that our theoretical knowledge of the comprehension process has not progressed very far beyond the observations of early reading researchers such as Huey (1908), James (1890), Richards (1929) or E. L. Thorndike (1917). While the observations of these early theorists contain many insights into the processes involved in comprehension, our view is that real progress toward the development of a psychologically valid theory of comprehension has emerged only recently from attempts to develop process models of human cognitive functioning.

In the paper which follows, we will propose a minimal principle of comprehension which we have derived from recent theoretical and empirical work on the comprehension process. This principle, we believe, must be part of any serious theory of comprehension. In subsequent sections we will review several types of models of the comprehension process and show how our minimal principle is integrated within them, derive the implications of the minimal principle for the measurement of comprehension, and propose alternatives to the existing methods of measuring reading comprehension.

A Minimal Principle of Reading Comprehension

The purpose of this section is to present arguments in support of a minimal principle of comprehension. Our use of the term "minimal" is self-descriptive in that we believe this principle must be part of any serious theory of comprehension. The principle is that the act of comprehension entails an interaction between an incoming linguistic message and the comprehender's world knowledge. This principle can take a weak and a strong form. The weak form of the principle suggests that the reader's prior knowledge plays a part in the perceptual aspects of the reading process. This would include activities such as identifying features in letters, attaching speech sounds to particular letter and spelling patterns, and identifying words and word meanings. In the weak form of the minimal comprehension principle the act of comprehension entails a process of stringing together a sequence of derived word meanings until a "unit" (e.g., sentence, phrase, proposition) has been achieved and then proceeding on to the next unit.

The strong form of the minimal comprehension principle suggests that the letter and word identification processes mentioned above merely set the stage for the act of comprehension, and that beyond these there is another sort of interaction between linguistic input and prior knowledge which must occur before the learner forms a stable representation of what is being read. This additional form of interaction operates on larger "units" than previously discussed (though activities like word identification and word meaning may be affected) and is responsible for the "click of comprehension."

One way to think about the difference between a strong and weak form of the minimal comprehension principle is to distinguish between a reader's dictionary and a reader's encyclopedia as Clark and Clark (1977) have done. They suggest that a reader's dictionary consists of a mental storehouse of information about words, with each word in a reader's vocabulary having three entries: the pronunciation of the word, its syntactic category, and the meaning of the word. In comparison, the encyclopedia contains all of the individual's world knowledge as it relates to words. So, for example, one's encyclopedia entry for the word Jog might contain information about appearance, function, typical behavior, origins, history, experiential facts, etc. (Clark & Clark, 1977, p. 411)

Given this distinction, the difference between a strong and a weak form of the minimal comprehension principle can be conceptualized as follows. The weak form of the minimal comprehension principle suggests that the reader looks up the meaning for each word in the dictionary and then strings the meaning of the individual words together to form the "comprehended" message. In contrast, the strong form of the minimal comprehension principle suggests that the reader consults both the encyclopedia and the dictionary. This means that the mental representation for a comprehended message would contain more information than was contained in the message itself. That is, our world knowledge contributes to and elaborates the incoming linguistic message.

Our preference is for the strong version of the minimal comprehension principle and much of the remaining section will be devoted to developing support for this preference. We will first argue that comprehension is a natural

extension of the perceptual process, and since the perceptual process is a constructive process, the comprehension process is likely to be also. Later, we will consider several ways in which world knowledge may interact with an incoming linguistic message during the comprehension process.

Perception and Comprehension as Constructive Processes

Our knowledge of the physiology and biochemistry of the perceptual process, along with the results of a great many studies having to do with the recognition of partial figures, visual illusions, pattern recognition, etc., have led to the conclusion that visual perception is a constructive process (cf. Neisser, 1967). That is, the perceiver must take a raw pattern of electrochemical stimulation derived from a pattern of light, and construct some meaning from that pattern. This interpretation process could work only if there were some record of similar patterns experienced in the past, and there was some way of linking the incoming pattern of stimulation to the previously recorded (and presumably labeled) patterns.

There would surely be little argument that some aspects of the reading process involve an interaction between incoming stimulation and prior knowledge. Letter and word identification, for example, must involve processes in which particular patterns of stimulation are linked to records of past experiences.

But we want to make a stronger claim for the minimal comprehension principle. We want to argue that the processes leading up to the identification of the meaning of a word simply set the stage for the act of comprehension. After the stage has been set, there is a further interaction between the linguistic input and prior knowledge which results in stable comprehension.

The arguments and evidence required to fully support our claim about the act of comprehension would require more space than we have available in this article. But we will present several arguments, and several of the lines of evidence, which we feel give the flavor of a more complete and compelling argument (see, for example, Anderson & Ortony, 1975; Bransford & McCarrell, 1974; Spiro, 1977) supporting the strong version of the minimal comprehension principle.

It is obvious that we can read text--that is, process the printed text up to the point of determining what the words mean--and still not comprehend it. Bransford and McCarrell (1974) have presented some simple, yet striking, illustrations of this. Consider these three sentences from their recent article: The notes were sour because the seam split. The haystack was important because the cloth ripped. The trip was not delayed because the bottle broke. Most of us, when reading these sentences for the first time, do not experience the "click" of comprehension. This is so even though we understood each of the words. However, in the context of the words, bagpipe, parachute, and ship launching the sentences become immediately understandable.

We believe that the Bransford and McCarrell (1974) sentences illustrate a fairly common situation. When our respective mothers sit down and read our latest articles (as they do), or when we sit down and read a book on Eastern religions (as one of us has recently attempted), the letters are identified, and meaning is attached to the words, but the sense of comprehension is uncertain.

The examples mentioned above can be interpreted in the context of Clark and Clark's (1977) previously mentioned distinction between the dictionary

and the encyclopedia. It is possible to imagine an instance where the words in a sentence have been located in the dictionary, but comprehension is difficult because encyclopedia entries cannot be located which allow an interpretation of the words in context. We believe that this is precisely what happens when encountering the Bransford and McCarrell sentences for the first time.

The importance of consulting the encyclopedia while reading is apparent when considering a problem like the interpretation of polysemy. How, for example, do we comprehend each of the following sentences?: Bill ran for mayor last fall. Sally ran to the store. The brook ran down the valley. The clock ran down last night. As it happens, run is an extraordinarily polysemous word (52 distinct meanings in our desk dictionary), and it is difficult to imagine that our understanding of each of the above sentences is dependent upon retrieving the particular meaning which would allow a sensible interpretation of the sentences. Instead, it must be the case that the environmental context in which each of the sentences is heard, and the sentential context for the word run, interact with our world knowledge to construct an interpretation of the sentences. Anderson and Ortony (1975) have presented several elegant arguments, and some compelling empirical evidence supporting this point.

As another example of the necessity of world knowledge in interpreting text, consider the frequency with which we encounter, and the ease with which we understand, figural speech. Similes such as, "man is like a computer," or, metaphors like, "encyclopedias are goldmines," are encountered and understood many times a day. Yet it would be impossible to understand these

sentences if the reader were dependent on individual word meanings. Context as it relates to world knowledge is critical also. Consider the metaphorical phrase, "sheath thy impatience," which means one thing in the context of a discussion between a man and his young protege, and quite another in the context of a discussion between two lovers.

These considerations lead us to the conclusion that the processes leading up to the determination of individual word meanings are necessary but not sufficient conditions for comprehension. In order for comprehension to occur, there must be an interaction between the linguistic string and the reader's world knowledge base.

If it is the case that comprehension is a constructive process resulting from an interaction between prior knowledge and the incoming linguistic message, then it must also be the case that memory representations which result from the comprehension process will be influenced by both the incoming linguistic message and the particular knowledge possessed. Since no two individuals have the same experiential history, there will be differences in both the quantity and quality of prior knowledge which is relevant to the interpretation of a given linguistic message. Thus, any two individuals will have a somewhat different representation of the same event. We will refer to this phenomenon as <u>representational variability</u> since its effects are observed on the outcome (the memory representation) of comprehension and not on the comprehension process <u>per se</u>. The implications of representational variability will be considered in a later section of this paper.

A Framework for Viewing Comprehension Processes

A visual representation of the viewpoint we have been arguing is presented in Figure 1. We do not claim that this framework is a formal model of comprehension, nor do we claim, as the figure might suggest, that comprehension involves a linear progression through a series of discrete stages. Our Figure merely identifies processes or activities which must (solid lines) or may (dotted lines) be operative in comprehension. Thus, we believe that the comprehension process must entail the reception of linguistic information, the decoding of information with the aid of input from perceptual prior knowledge, and an act of comprehension which involves an interaction between world knowledge and the decoded linguistic message (our minimal comprehension principle). Factors which may be operative (dotted lines) are that perceptual knowledge may influence the actual reception of information, that world knowledge and cognitive strategies may play a role in decoding, and that the reception, decoding, and comprehension stages are interactive. These latter factors are supported in several models of the comprehension process (e.g., Clark & Clark, 1977; Schank, 1972), and Rumelhart (1977) has presented compelling arguments that comprehension processes must be interactive at all levels. The reason that the view presented in Figure 1 falls short of a formal model of comprehension, is that it fails to specify how the processes we have identified actually operate and interact. Later in the paper we shall review several models which have more fully inquired into the nature of these processes.

The second limitation of Figure 1 is that it fails to adequately portray the interactive nature of comprehension. The processes identified are not presumed to operate sequentially or discretely. Linguistic decoding, for instance

can involve input from sense receptors, recently comprehended information, world knowledge, and perceptual knowledge and simultaneously be outputting information to comprehension processes, our store of world knowledge, etc. Furthermore, several messages can be operative in the system simultaneously, (for example, when one message is being comprehended, another may be undergoing linguistic decoding).

Insert Figure 1 about here

In the sections which follow, we will review several types of models which have elaborated upon the nature of the processes identified in Figure 1. While the details of these models will differ, we believe that the basic processes proposed in these models are compatable with those portrayed in Figure 1.

How the Minimal Comprehension Principle Might Work

In the previous section we claimed that prior knowledge played a direct role in the language comprehension process. In this section of the paper we will examine specific ways in which prior knowledge might influence comprehension. This examination will include a brief review of a number of theories of reading comprehension.

Language representation and the minimal comprehension principle. If someone reads or listens to a linguistic message and then a short time later is questioned about what had been read or heard, we would find that they had excellent memory for the meaning of the message but relatively poor memory for its surface form (e.g., Sachs, 1967). We also know that multilinguals appear to process different languages from a common base, and that pictures and verbal

materials are frequently translated into a common representational form in memory (e.g., Loftus, 1975; Loftus, Miller & Burns, 1978; Pezdek, 1977). And finally, we know that when a message is comprehended, the prior knowledge which is relevant to interpreting the message becomes part of the representation of that message. For example, the representation of the sentence, "I like apples." (Schank, 1972) will include the notion that the speaker is expressing an eating preference while such information would not be a part of the representation for the sentence, "I like Ike." Thus, it seems obvious that one part of the comprehension process involves inferences which are not part of an experienced linguistic message.

All of the above facts point to the conclusion that there is not a one-to-one correspondence between language as it is experienced and language as it is represented in memory. A number of theorists of language comprehension have acknowledged this conclusion and have attempted to develop a formal theory of the process whereby language is transformed and added to during comprehension. In this section we will examine a number of these representation systems and the ways in which they are specifically influenced by prior knowledge.

Kintsch's theory. Walter Kintsch (1974) (Kintsch & Vipond, in press) has proposed one of the most comprehensive and explicit theories of language comprehension. Kintsch proposes that the meaning of text can be represented in the form of a text base, which is a structured list of propositions. Propositions consist of a predicate with one or more arguments, and an argument is a concept, or a proposition itself. Concepts are realized at the language level by a word (or words if there are synonyms) or at times by a phrase. In

essence, propositions are idea units representing a single idea. As Kintsch (1974) has written, "It is suggested here that propositions represent ideas, and that language (or imagery) expresses propositions, and hence ideas. Thinking occurs at the propositional level; language is the expression of thought" (pg. 5).

As an example of Kintsch's representational system, the sentence, "A great black and yellow V-2 rocket forty-six feet long stood in the New Mexico desert," would be represented as: (1) (GREAT, ROCKET), (2) (BLACK, ROCKET), (3) (YELLOW, ROCKET), (4) (V-2, ROCKET), (5) (LONG, ROCKET), (6) (FORTY-SIX FEET,5), (7) (STAND, ROCKET), (8) (IN, 7, DESERT), (9) (NEW MEXICO, DESERT). This example illustrates several of the conventions used in the representation system. The names of concepts, as distinguished from words, are written in capital letters, and the predicates in the propositions are written first. In addition, the propositions are numbered such that when one proposition serves as an argument for another (as in six and eight above), the number of the proposition is written rather than writing out the proposition in its entirety.

Another aspect of Kintsch's representational system is text cohesion. Text cohesion is a concept which captures the difference between a list of numbered propositions derived from a written text, and a list of numbered propositions derived from random phrases. Kintsch suggests that the difference lies in the degree of argument repetition. As an example, note that eight of the nine propositions in the sample sentence show the argument ROCKET. Thus, an index of the degree of coherence present in a text is the extent to which arguments are repeated across propositions.

Kintsch has presented evidence to the effect that coherence in text is directly related to the ease of understanding of the text. Thus, a text which is highly coherent (having much argument repetition) will be easier to understand than one which is less coherent. In essence, what Kintsch is saying is that new information in text will be understood more easily if it has recently been preceded by related information. This principle can be extended to extratextual information. Text will be understood more easily if the incoming arguments can be related to knowledge already in memory. The reasons for this facilitation become clear upon examining the processing aspects of Kintsch's theory. The interested reader should examine Kintsch (1974) for the details of Kintsch's processing description.

Kintsch's theory contains a number of instances of the critical role of prior knowledge in constructing a memory representation for a linguistic event. First, Kintsch proposes a pattern matching phase in which an incoming linguistic message (consisting of perceptual elements) is matched to a semantic memory trace which consists of phonemic, graphemic, syntactic, semantic, and experiential features associated with a given word. The perceptual and semantic elements then combine to form an encoding for the event. Thus, prior knowledge, in the form of semantic memory elements, is involved very early in the comprehension process.

Prior knowledge also influences memory representation in Kintsch's theory through the role of short-term memory. Propositions which are already in short-term memory are presumed to influence both the pattern matching phase and the encoding phase of the representational process. If needed, propositions can also be called from long-term memory to aid in text interpretation.

This would occur, for example, when the propositions presently in short-term memory were not relevant to the interpretation of incoming propositions.

Thus, it seems obvious that the minimal comprehension principle is operative at a number of stages in Kintsch's theory. In a later section of the paper we will consider what might happen when a reader does not possess the knowledge needed to interpret a text. This is what Kintsch and Vipond (in press) have to say about this situation:

> Another way in which knowledge would be beneficial--in fact crucial--in comprehension is in the inference processes that are required whenever an incoherent text base is constructed. We have suggested that these inferences constitute a major source of reading difficulty. For high-knowledge readers this difficulty should be greatly reduced, whereas for readers without the necessary knowledge it would be insurmountable and lead to the formation of disjointed, impossible to retrieve text bases. (p. 232)

Schank's theory. A second formal theory of language representation has been offered by Roger Schank (1972). The basic unit in Schank's theory is the concept, of which there are three kinds. A concept can be a nominal, an action, or a modifier. A nominal is something which can be thought of by itself, without the necessity of relating it to some other concept. Concrete objects are the clearest example of nominals, and in fact, Schank refers to nominals as things which tend to produce pictures in the mind and abbreviates them as PP's (picture producers).

An action--which Schank abbreviates ACT--is something that a nominal does. In general, actions take the form of verbs at the language level.

A modifier is a concept which means nothing without the nominal or action to which it relates. The purpose of the modifier is to specify an attribute of a nominal or an action. Schank refers to two types of modifiers: those which modify nominals (which he refers to as PA's, for picture-aiders) and those which modify actions (labeled AA's, for action-aiders). In general, modifiers take the form of adjectives and adverbs at the language level.

In addition to specifying categories of concepts, Schank also specifies the way in which the categories can relate to one another through what he calls "dependencies." A dependency relationship between two conceptual items indicates that a dependent item requires the presence of a governing item, but the converse is not true. That is, a dependent must have a governor, but a governor need not have a dependent. Using Schank's terminology, PP's and ACT's are inherently governing categories, whereas PA's and AA's, are inherently dependents.

Using the basic categories mentioned above, and the notion of dependencies (greatly simplified here) as a means of linking concepts to one another, Schank constructs what he calls "conceptual dependency networks." In essence, a conceptual dependency network is a representational scheme which captures the conceptual elements of a language string, and the manner in which those elements relate to one another.

Having developed a conceptually based representation system, Schank then specifies the processing aspects of his theory. Language processing is divided into five stages or processors: (1) a syntactic processor which performs a preliminary syntactic analysis of a linguistic string; this analysis includes activities such as finding main nouns and verbs in sentences, separating words

into their syntactic categories, and predicting the syntactic category of an upcoming word based on the syntactic analysis of the current word; (2) a conceptual processor which separates words into their conceptual categories and identifies the dependency relationships that exist between the categories; (3) a conceptualization-memory interface which among other things relates two concepts or conceptual structures based on the individual experiences of the hearer, finds the functions of PP's in the real world, and searches through conceptualizations for information to be stored in long-term memory; (4) intermediate memory whose function is to begin responses to incoming conceptualizations and to interact with long-term memory; and (5) long term memory which is the repository of information about particular subjects and experiences.

It should be noted that Schank's view of the activities of the above processors is interactive rather than sequential. In his words, each of the processing stages "talk together while they work." This means that the activities of one of the more basic processors (e.g., the syntactic processor) can be affected by higher order processors (e.g., intermediate memory) and vice-versa.

In Schank's theory the involvement of the minimal comprehension principle begins to explicitly come into play in the conceptualization-memory interface where memory is consulted to determine the function of a given PP in the real world. The minimal comprehension principle is even more apparent in the activities of intermediate memory. There information from long-term memory is combined with input conceptualizations so that an interpretation process can occur.

Schank's interpretation process utilizes the conceptual dependency networks in conjunction with overall memory structure to establish what the linguistic string "really means." As an instance, he cites the case of someone coming into your office and saying, "Fire." It is obvious that the appropriate interpretation of this utterance requires reliance on prior knowledge. In a similar fashion, we must bring our prior knowledge to bear in order to conclude that the sentence, "The man lit a thoughtful cigarette," is acceptable, while the sentence, "The man lit a thoughtful fireplace" is anomalous (Lakoff, Note 1). And if prior knowledge does not contain the appropriate information, it will be difficult to establish a stable interpretation of the message.

Schema theories and the minimal comprehension principle. Another view of how prior knowledge influences comprehension is contained in schema based theories. Rumelhart and Ortony (1977) and Schank and Abelson (1977) (they use script rather than schema) have written on how schemata influence the understanding process in general, and Anderson (in press) and Adams and Collins(in press) have presented views on how schemata specifically affect the reading comprehension process.

A schema can be conceptualized as a generic data structure which contains "slots" or place-holders for frequently experienced events. So, for instance, we could have a schema for recipes which would contain slots for ingredients, preparation instructions (mixing, etc.), and cooking instructions. Another example is the restaurant schema described by Schank and Abelson (1977). Consider these sentences and the question which follows as an instance of the use of a restaurant schema (Abelson, Note 2): John went to a seafood restaurant for dinner. He ordered lobster. He paid with his credit card. What did

John have to eat? The answer to the question is so obvious that one has a sense of amazement upon realizing that the story says nothing about what John had to eat. It seems apparent that our prior knowledge about restaurants set up some expectations about the message being comprehended. In a sense, our schema for restaurants added considerably to the content of the message which was read.

Schemata can be said to exert their influence on comprehension in two principle ways: (1) they facilitate the memory representation process, and (2) they fill in missing content essential for complete understanding. When we experience the same event repeatedly--whether that event is a sequence of actions as in the recipe schema or a more abstract event such as reading a journal article--we establish schemata for recording the essential content of those events. When the event is encountered representation of the event in memory occurs easily because there is a pre-established structure for recording the content of the event. In contrast, when information is encountered for which there is not a pre-established data structure, representation (and comprehension) is difficult and laborious. In this case a data structure must be fabricated from what may be ill-suited existing structures. Events recorded in such a way are likely to be forgotten quickly.

The second way that schemata influence comprehension is by filling in missing data slots. Even an unsophisticated analysis of the language we experience while reading or listening reveals that an extraordianry amount of inferencing must occur during the language comprehension process. When the communications we receive are about familiar topics schemata automatically compute values for content which may have been left out, but which is essential for

understanding. In contrast, when we do not have a schema for interpreting text content we have to consciously reason out what the missing content might be. This process is slow, laborious, and not always successful.

Linguistic conventions and the minimal comprehension principle. In this section we will consider several ways linguists and psycholinguists see prior knowledge influencing the comprehension process. These ways fall under the rubric of what are called linguistic conventions; that is, unstated agreements as to the form, purpose, and function of linguistic communications.

Herbert Clark and Eve Clark (e.g., 1977) have written extensively about what they call the given-new contract. They suggest that every assertion made by a speaker or writer can be broken into two parts which can be distinguished by structural features of sentence: given information already known to the listener, and new information which the speaker believes to be true but is not known to the listener. Further, they suggest that there is an unstated "contract" between speaker and hearer to construct sentences within the given-new framework. When a listener (or reader) hears an assertion they divide a sentence into its constituent elements, search memory for the given part of the assertion, and add the new information to it.

The role of prior knowledge in the above description is obviously critical if one accepts the generalization that assertions always contain given and new information. If the given information is not in the comprehender's memory, it will be difficult to understand and represent in memory the new information.

A distinction similar to the given-new contract has been made by Halliday (1970) in his discussion of the thematic content of linguistic messages.

Halliday suggests that a speaker's (or writer's) judgement about a listener's current mental state is reflected in what is called thematic structure. In a sense, thematic structure reflects a constantly updated assessment of what a listener knows at any given point in time. Greatly simplified, the thematic content of a linguistic string is a concept which captures the notion of new information the speaker wants to convey combined with the speaker's assessment of what the listener already knows. The importance of prior knowledge in this concept is obvious.

A third linguistic convention is the notion of speech acts (Searle, 1975). Searle suggests that all linguistic utterances can be classified into five categories of speech acts: (1) Representatives--where the speaker is conveying the belief that some proposition is true, (2) Directives--where the speaker is trying to get the listener to do something, (3) Commissives--where the speaker is committing himself to some future course of action, (4) Expressives--where the speaker wishes to convey something about his "psychological state," and (5) Declaratives--where the speaker produces some new state of affairs as a function of the utterance (e.g., You're fired!).

The intent of Searle's (1975) classification system is to formalize the idea that what one understands a message to mean will depend in part on what one perceives the purpose of the message to be. This is another instance of the way in which prior knowledge influences the comprehension process.

The final linguistic convention to be discussed here is the notion of types of discourse (e.g., Cunningham, 1978). This view holds that humans have developed particular stylized ways of communicating information via discourse including such modes as narratives, exposition, description, etc. Each of these

types is presumed to have particular structural characteristics associated with it. For example, Rumelhart (1974) has proposed a grammar which he believes describes the structural characteristics of well formed simple stories. It is further assumed that through exposure to these various forms of discourse, humans develop cognitive structures which correspond to the structural characteristics of the discourse type. These cognitive structures govern the set of expectations that readers have about the type of information which should occur in a given text. These expectations in turn influence how incoming text information is processed and remembered.

To date, the majority of research on types of discourse has dealt with a single type of text--the simple story. For example, Thorndyke (1977), building on the work of Rumelhart (1974), has attempted to document the validity of this grammar of stories, conceived as a set of rules by means of which such stories are structured. A story is conceived as consisting of a setting, theme, plot, and resolution, each of which is further decomposed into subcategories. The validity of this model was tested by inspecting the pattern of subject recall of the stories with respect to the categories proposed and the relations among them. Predictable differences in recall were found as a function of these categories in "ideal" stories and in stories in which some of the categories were deleted or rearranged. Stein and Glenn (1977) have been proceeding independently along similar lines but have, in addition, identified interesting developmental differences in children's ability to comprehend various structural features of stories. Knowledge of the conventions employed in various discourse is thus another example of the importance of prior knowledge for comprehension.

In summary, each of the positions we have reviewed agrees that prior knowledge plays a critical role in the comprehension process. The theorists emphasize different types of knowledge crucial to comprehension, but they would all agree that the minimal comprehension principle is an essential part of any theoritical effort.

Implications of the Minimal Comprehension Principle for the Measurement of Reading Comprehension

Thus far in the paper we have claimed that prior knowledge has a direct and critical role in the language comprehension process, and we have suggested several ways in which prior knowledge could influence comprehension. In this section of the paper we will trace the implications of the minimal comprehension principle for the measurement of reading comprehension.

If one accepts the plausibility of the strong version of the minimal comprehension principle, there are two classes of reasons why a reader might not satisfactorily comprehend a segment of written text. The first class of reasons is that the reader might fail to fulfill the lower level requirements for text comprehension. That is, due to poor basic skills such as the decoding of words and word-identification, or the inability to combine individual words into coherent messages, the reader fails to comprehend the text. The second class of reasons for poor comprehension is that the reader may lack the world knowledge necessary to establish a stable interpretation of the linguistic message. This could result in the inability to construct an interpretation of the message, or it could result in an interpretation that was so unstable or deviant (e.g., implausible) that it disrupted subsequent comprehension. In

either case, it could be concluded that the reader did not grasp the intended understanding of the text.

In the paragraphs which follow we will claim that most existing tests of reading comprehension cannot distinguish between the two classes of reasons mentioned above, and that this restricts the utility of the tests to situations where one wants an instrument to predict future comprehension performance, rather than assessing or diagnosing current comprehension performance. Further, we will suggest that the inability of the tests to distinguish between the two classes of reasons for poor performance may have the consequence of underestimating the reading gains achieved by national reading programs.

Question Type, Passage Content, and the Relation Between Reading Comprehension Tests and Ability Tests

The typical reading comprehension test asks the reader to read a segment of text, and then, either during (in the case of cloze tests) or after reading, the reader selects one of four alternatives as a response to a question or blank. We want to examine both the type of questions asked and the content of the text sample in light of the minimal comprehension principle.

There are two kinds of questions readers respond to on reading comprehension tests. The first kind of question can be answered solely on the basis of the passage content the student has just read. As is traditional, we will call this type of question a literal comprehension question. Other questions (or blanks to be filled in) require that the reader draw on information that has just been read, and on information acquired previously, in order to respond correctly. Again in accordance with tradition, we will call these inferential

comprehension questions, since responding correctly to these questions requires that the reader draw together just read and previously known information.

There are two important things to note about inferential comprehension questions. The first is that they require that the reader perform an inferential reasoning activity. If the required reasoning activity is at all difficult, it is likely that reasoning ability will play a part in determining reader performance.

The second thing to notice about inferential questions is that successful performance is dependent on the reader having appropriate prior knowledge. Imagine, for example, that a passage in a reading comprehension test tells about a boy and his father going camping. Further, imagine that one of the questions asks the reader, "What did Tom's father probably use to cut the firewood?" Obviously, the reader who has acquired information about camping--or better yet, gone camping--will do better than readers who do not have this information in memory.

The extent to which prior knowledge is shared between the test constructor and test taker will be important also. This point relates to the representational variability issue raised in the introductory section of this paper. If a reader and a writer have quite different experiential histories, it is possible that a reader could construct an interpretation for a text message that is different from the one the author intended. The reader would, in this case, perform poorly on questions probing for the author's intended text interpretation, even though the reader had constructed a perfectly sensible (based on his experiential history) text interpretation of his own.

The two examples above point to the conclusion that the broader the general knowledge base of a reader, and the greater the extent to which author and reader share a common knowledge base, the more likely it is that the reader will perform well on inferential questions based on the text passages.

The fact that prior knowledge plays a part in answering inferential questions has been empirically documented. Jim Pichert (personal communication), for example, recently asked seventeen secretaries and staff members at the Center for the Study of Reading, University of Illinois, to complete the test items on a commonly used reading comprehension test (about fifth grade level) without reading the passages. The average score was 33 correct out of a possible 45. In addition, for 36 out of the 45 items, the scores were significantly above chance. One might argue that Pichert's demonstration is not that convincing since the tests were not designed for use with adult populations. However, both Pyrczak (1972) and Tuinman (1973-74) have shown similar effects (though of lesser magnitudes) with subjects using age appropriate materials.

The claim that reasoning ability and the extent and nature of prior knowledge influences performance on inferential test questions leads to a general conclusion: independent of reading skill, there will be a relationship between general ability (as indexed by ability tests) and performance on inferential comprehension questions. This conclusion follows given that one believes that reasoning ability and extent of knowledge acquisition are both components of (or resultants of) general ability.

Let us now turn to the issue of passage content in reading comprehension tests. This is largely speculation, but we believe that the content of reading

comprehension test passages can best be understood in the context of the cultural bias issue--with cultural bias being the extent to which test content unfairly favors one cultural group over another.

In general, developers of mental tests have been very sensitive to the issue of cultural bias in tests, and the developers of reading comprehension tests are no exceptions to this rule. One way that a test developer can guard against task irrelevant bias creeping into a test is by keeping to a minimum the degree of cultural loading (cf. Jensen, 1976) in the test. Cultural loading is a term used to describe the degree of cultural generality or specificity for a given test item. Thus, the more narrow or less general the culture in which the informational content of the item could be acquired, the greater the degree of cultural loading for the item. So, for example, "Name the largest city park in San Francisco," is a high cultural loading item, whereas, "Name the first president of the United States," is a low cultural loading item.

The concept of cultural loading is applicable to reading comprehension tests even though the focus is not on test items. Instead, one can think of the topical content of test passages as being subject to cultural loading. So, for example, a passage about the ethnic diversity of New York City neighborhoods would have high cultural loading relative to a passage about taking an automobile trip to visit a relative.

Our speculation is that developers of reading comprehension tests have either consciously, or perhaps intuitively, attempted to avoid the charge of culturally biased tests by utilizing reading passages containing content equally accessible (in theory) to all members of the population. So, for

example, one popular reading comprehension test contains successive passages about owning waterfront property, the behavior of hummingbirds, and world class milers. Taken as a group, it is reasonable to assume that the information about these topics is equally accessible to all members of the population. However, equal accessibility does not mean equal acquisition.

By definition, the information required to interpret a low culturally loaded passage is not likely to be acquired by interacting with one's immediate environment. Instead, the information must be acquired from sources conveying information about the surrounding world. This means that acquisition of low cultural loading topical content (through reading, conversation, popular media, educational media, etc.) is likely to be related to variables like socioeconomic status, which in turn are strongly related to performance on aptitude tests. This assumes that socioeconomic level is likely to be related to the degree to which one takes advantage of sources of information about the world outside of one's immediate environment.

The line of reasoning pursued above, when joined with the implications of the minimal comprehension principle, leads to the conclusion that those who take advantage of sources of knowledge about the surrounding world are likely to be in the best position to interpret the content in reading comprehension test passages, and further, those who take advantage of knowledge acquisition opportunities are also likely to be those who enjoy other advantages associated with higher economic status.

In the previous paragraphs we have discussed the types of questions asked on reading comprehension tests, and the type of content contained in test passages, and have concluded that each of these features contributes to some extent

to the relationship between reading comprehension test performance and ability test performance. The important point in this conclusion is that some part of a reader's comprehension test performance is independent of reading skill, per se. That is, when a student performs well on a reading comprehension test we can safely say that he has mastered appropriate reading skills. But what can we say when he performs poorly? Poor performance might be attributable to lack of basic reading skills, or it might be attributable to a lack of prior knowledge necessary to interpret the text. We have no way, from the test at least, of determining which of these is the case.

In the next section we will trace the implications of this dilemma as they relate to the uses for reading comprehension tests.

The Uses for Reading Comprehension Tests

Reading comprehension tests can be used for three general purposes which can be discussed from the perspective of the framework presented in Figure 1. The purposes are: (1) to predict future comprehension performance; (2) to diagnose reading difficulties; and (3) to assess educational gain. Current tests of reading comprehension differ in the extent to which they can satisfy each of these purposes.

One use for reading comprehension tests is to predict future performance. This means that on the basis of a score obtained now, one would like to predict performance on a future occasion where both the time of testing and the nature of the reading materials are unspecified. A test which would be ideally suited for this purpose would be one which tapped both general reading skills, and range of prior knowledge; since these are two attributes which are going to be critical in an unspecified future occasion.

Referring to Figure 1, a test designed for predictive purposes would be sensitive to all of the activities depicted in the figure. That is, since the successful word identification act must involve the ability to receive and decode linguistic information, and since the comprehension act must involve an interaction between a decoded linguistic message and world knowledge, a good predictive instrument would be one which tapped abilities relevant to all of these activities.

Many of the standardized reading comprehension test currently in use seem ideally suited for the purpose of predicting reading comprehension performance. Successful responding to the questions on a test, or to the blanks in a cloze test, assures that examinees possess basic decoding skills. In addition, the presence of low cultural loading text passages means that performance is going to be influenced by the extent of world knowledge. As an added feature, most standardized tests are sensitive to reasoning and inferential abilities. This is particularly true of cloze based tests, and is true of reading comprehension tests in general to the degree that one author has concluded that "if reading isn't reasoning, then maybe reasoning is reading" (Thorndike, 1973-74). The inclusion of reasoning ability probably adds to the ability of the test to predict performance on some future occasion since reasoning ability may, as Kintsch and Vipond (in press) have suggested, be very important in interpreting text having an incoherent text base.

The evaluation that current comprehension tests seem ideally suited for predictive purposes does not mean that we believe they are ideal predictive instruments. Rather, we believe that the tests lend weight to those factors,

illustrated in Figure 1, which are going to be important in comprehending an unspecified text sample at a future point in time.

Whereas we are positive about the use of current comprehension tests for predictive purposes, we are less sanguine about their use for diagnostic purposes. The problem is that one cannot tell whether poor performance means that the student is deficient in reading skills, or whether it means that he does not have the prior knowledge needed to construct an interpretation of a text passage. Given the inability to distinguish between these two classes of reasons for failure, the test has minimal utility as a diagnostic instrument.

The problem can be illustrated by reference to Figure 1. When diagnosing reading difficulties the most basic decision that needs to be made is that a difficulty exists. But in tests where weight is given to extent of prior knowledge one can never tell whether poor performance is due to lack of some critical reading skill, lack of world knowledge needed to interpret the text, or to some failure in the process whereby a decoded message interacts with appropriate prior knowledge. This suggests the possibility that failure could occur--due to lack of relevant world knowledge--when the student had perfectly good reading comprehension skills.

Many tests of reading comprehension contain item type features which presumably are for diagnostic purposes. So, for example, one can get scores for identification of main ideas, sentence meaning, recall of facts, inferred meaning and character analysis, and authors attitude and techniques of persuasion. Aside from the world knowledge problem there is some question as to whether these item types have diagnostic utility. The first difficulty is that

the subscores are generally based on a small number of items which results in considerable instability in the scores. But more important is the fact that the subscores are rarely keyed to a theory or model of the comprehension process. Instead the scores generally are named after skills thought to be important in reading instruction, or after factor labels derived from factor analyses of reading comprehension tests. As yet, there is no research which demonstrates that there is a relationship between knowledge of the sort provided by comprehension test subscores and improvement in instructional decision making.

Most reading comprehension tests are also not well suited for the purpose of assessing educational gain. Since this is probably the most frequent use for the tests--and certainly, from an educational policy point of view, the most critical--we will develop our position, and its ramifications, with care.

There are several reasons why most reading comprehension tests are ill-suited for the purpose of assessing educational gain. Among these are score interpretation procedures which emphasize comparisons between individuals rather than within individuals, and item selection techniques which produce tests with good predictive properties, but relatively poor assessment properties (see Carver, 1974, for an excellent discussion of these). Our focus, however, will be on the property we discussed previously: the inability to determine whether poor performance is due to poor reading skills or to lack of critical prior knowledge.

A reading comprehension test used for the purpose of assessing educational gain should be able to identify the extent to which a text sample is comprehended,

and it should document comprehension gains which occur from one test occasion to the next. This means that the test should be sensitive to reading skill gains, but it should not be sensitive to world knowledge gains. Our previous discussion of the implications of the minimal comprehension principle indicated that most tests of reading comprehension do not satisfy these requirements.

Let's take a concrete example. Assume that a student at the beginning of a school year achieves a raw score of 45 (we'll ignore the problem of what standard scores mean). After a year of remedial instruction the student is tested again, and again scores 45. Does this mean that the instruction has failed (ignoring the possibility of measurement error)? The problem is that we can't tell. The student may have improved considerably in reading skills, but lacks the knowledge base needed to construct the intended interpretation of the test passages. Notice that this problem occurs in the case of gains also. Assume that our student who scored 45 at the beginning of the school year scores 60 at the end of the year. Does the gain reflect an increase in skills as a function of instruction, does it reflect an increase in the student's knowledge base, or does it reflect some combination of both of these?

While the examples above may be extreme, they illustrate the dilemma associated with using current comprehension tests to document educational gain. Considering the extent to which reading comprehension test scores have contributed to educational policy over the past ten to fifteen years, the implications of this analysis are profound. We are suggesting that most reading comprehension tests can be insensitive to gains in reading skills, and moreover, that the tests are <u>most likely</u> to be insensitive to gains in those very groups where the documentation of gain would be most important.

The conclusion above follows from our previous argument about the relationship between socioeconomic status and performance on reading comprehension tests. We argued that low socioeconomic groups were likely to have a world knowledge deficit relative to more advantaged groups because of a lower likelihood of taking advantage of sources of world knowledge. This deficit would result in an increased probability that a student would perform poorly on the test because of lack of knowledge needed to interpret the text. And this, in turn, would result in a relative insensitivity of the test to actual educational gain. And, of course, it is true that the bulk of the remedial reading effort in this country is targeted at the lower socioeconomic segment of our society (Title 1 of the ESEA, for example, dictates this).

It is a fact that in the last fifteen years programs designed to improve reading skills in disadvantaged populations have had disappointing results, when those results have been indexed by standardized reading comprehension test. We are suggesting that at least part of these disappointing results could be attributable to an insensitivity of the tests to instructional gain. This leaves open the possibility that true instructional gain occurred.

Recommendations for the Measurement of Reading Comprehension

In the previous section it was argued that most reading comprehension tests were not ideally suited for the purposes of diagnosing reading problems and assessing educational gain, but the tests were better suited for the purpose of predicting future comprehension performance. In this section we will

discuss ways in which comprehension tests could be constructed so as to improve their diagnostic and gain assessment utility.

According to our previous analyses, most test of reading comprehension are not good measures for diagnostic and evaluative purposes because one cannot distinguish between poor performance due to lack of reading skills and poor performance due to lack of critical world knowledge. In the paragraphs which follow it will be argued that a more suitable way to assess comprehension for evaluative and diagnostic purposes is to use techniques which are less sensitive to the influences of reasoning ability and prior knowledge. It will also be argued that an ideal diagnostic test must be based on a developmental theory of reading comprehension.

Before considering these arguments there are several theoretical issues which should be made explicit. Like Carroll (1977), we subscribe to the view that reading comprehension is a special case of language comprehension and that the extent of reading comprehension will be limited by the extent of language comprehension. This means that, in general, one would not be able to read and understand something that one could not listen and comprehend--given that the listening and reading situations were comparable.

We also subscribe to the view that comprehension entails a process whereby an incoming linguistic message interacts with the world knowledge base, and is transformed into a representation which preserves the meaning of the message, but not its form (Anderson, 1972; Sachs, 1967). This act of comprehension can be contrasted with other learning acts, such as rote memorization, where the form of the message may be preserved, but not its meaning. These

acts, such as the meaningless memorization of a foreign language phrase, would not, in our terms, involve comprehension.

Another assumption is that a comprehended message is represented in memory in an enduring fashion. There are issues involved in this assumption which are controversial. For example, John Carroll has written:

> If comprehension is a process that occurs more or less simultaneously with the reception of a message, we would be interested in the occurrence or nonoccurrence of that process only during the reception of the message or at least within a very short time lag. Thus, if memory is to be involved at all, it should be only what has been called short-term memory, i.e., memory that can fade within a few seconds. As soon as longer time-intervals are involved in the testing of comprehension, there is the possibility that we are studying memory processes along with, or in place of, comprehension processess. (1972, p. 6)

Carroll's position severely restricts the ways in which comprehension might be measured. One can either ask the examinee to respond to a message within a matter of seconds after receiving it, or one can ask the individual to respond to a message which can be reexamined at will.

There are a number of problems with Carroll's position. One of these is the fact that there is more evidence for individual differences in short-term memory (e.g., Hunt, 1977; Hunt, Frost, & Lunneborg, 1973; Hunt, Lunneborg, & Lewis, 1975) than there is for individual differences in long-term memory (e.g., Shuell & Keppel, 1970; Underwood, 1954; however, see Royer, Hambleton, & Cadorette, 1978, for a dissenting view), thereby raising a question as to whether memory effects can ever be eliminated, or even reduced. Another

problem is that there are inherent limitations in the two kinds of tasks (short term responding and free examination of the message) which meet Carroll's requirements. The short term responding task works ideally only in the situation where a behavioral response is supposed to follow a request, and it is difficult to generate sensible verbal questions--other than inferential questions--when the examinee can examine the message at will.

Our position is that comprehension processes and memory processes are inextricably intertwined. In fact, our definition of a comprehended message is in terms of the form of the message representation in memory. Further, we assume that a comprehended message will be retained in memory better than an uncomprehended message. There is ample evidence to support this assumption (e.g., Bransford & Johnson, 1972; Bransford & Johnson, 1973; Dooling & Lachman, 1971).

Having made our assumptions explicit, we are now ready to consider how to reduce the effects of prior knowledge and reasoning ability in comprehension testing, when the tests are to be used for evaluative purposes. The variability in comprehension test scores attributable to differences in prior knowledge could be reduced by matching topical content of the passages to the knowledge background of the examinees. In essence, what we are proposing is a kind of "tailored-testing" technique based on matching prior knowledge to topical content. One can imagine a sort of "passage bank" which would be akin to item banks which are now available for preparing criterion referenced tests. Teachers and administrators could then select passages from this bank which would be matched to the prior knowledge of a group of students, or even perhaps, to the prior knowledge of individual students.

The obvious question about the above proposal is how to determine which passages should be matched to which examinees. This is a questions which should be researched, but we do have several ideas about it. First, it may not be an enormous problem. Our guess is that teachers and administrators are very good judges of whether topical material will be in the knowledge repertoire of students in their charge. If this were not true there are ways in which the question could be approached objectively.

One way to objectively approach the topical content/prior knowledge match is to conceptualize prior knowledge as sets of schemata (cf. Anderson, in press; Adams & Collins, in press). Anderson (in press), for example, views schemata as structures for the representation of generic knowledge. Each schema is imagined to contain a slot for each bit of generic knowledge. Thought of this way, it is apparent that it is not specific information which will be important in the acquisition of related information. Rather, it is the extent to which the individual has acquired generic information related to the topic. This suggests the possibility that techniques designed to assess generic information would provide a good index of the extent to which a reader possesses prior knowledge needed to interpret text on a given topic. One way this might be done is to ask the individual to identify items which are generically true for a given topic (e.g., what is true of every baseball game you can imagine; or what is true of every cow that exists) when presented with a list which contained both generically true items, and items which were not generically true. Presumably, performance on this task would be related to the ease with which the individual could interpret the topical content of a passage.

The second concern in comprehension measurement is how to reduce the contribution of reasoning ability to test performance. Our proposals are based on a concept of how a comprehended message is represented in memory. We previously indicated that our concept of comprehension was the process whereby a linguistic message is translated into a representation which preserves the meaning of the message but not its surface structure. Thought of this way, one can distinguish between tests which assess the form of a memory representation versus tests which measure operations (cognitive manipulations) on that form. When used for evaluative purposes, the ideal comprehension test would be sensitive to the form of the memory representation, but insensitive to operations on that representation. The extent to which the test is sensitive to operations on the representation is the extent to which the test is likely to be measuring general ability factors in addition to reading comprehension, per se.

There are undoubtedly a number of ways of assessing the form of a memory representation without assessing operations on that representation. We will talk about three which might satisfy this requirement. The first is a technique which involves presenting examinees with linguistic materials and then asking them to choose a picture, from several presented, which best represents the meaning of the linguistic material. This procedure has been frequently used in foreign language comprehension tests (Carroll, 1971), and has been recently used with apparent success in a national assessment of reading skills conducted in Australia (John Elkins, personal communication). This latter use was particularly interesting since the test samples were drawn from a mock newspaper.

The picture identification task is theoretically consistent with our requirements since there is now ample evidence that pictorial and verbal material are frequently translated into the same representational form in memory (e.g., Loftus, 1975; Loftus, Miller, & Burns, 1978; Pezdek, 1977). This means that comprehension can be assessed by having the examinee match a representation derived from a picture, which presumably is easy to comprehend, to one derived from a verbal message. This matching process should occur with minimal cognitive operations on the two representations.

A second technique for measuring reading comprehension which may be insensitive to reasoning abilities is a variant of a sentence verification task (cf. Pezdek & Royer, 1974; Sachs, 1967) currently being investigated by J. Royer. This technique involves preparing four versions of each of the sentences in a text passage: (1) the sentence as it originally appeared; (2) a paraphrase of the original sentence; (3) a meaning change version of the sentence which preserves as nearly as possible the original wording in the sentence; and (4) a distractor which is similar in length and complexity to an original sentence and is semantically consistent with the topical content of the text passage, but is not semantically similar to any of the original sentences. An example of each of these types of sentences drawn from a story about trapping wolves is presented below:

(1) But morning after morning as I rode forth to learn the result, I found that all my efforts had been useless. (original)

(2) But day after day at early sunrise as I went forth to discover the outcome, I learned that all my attempts had failed. (paraphrase)

(3) On morning after morning as I rode forth to learn the result, I found that all my efforts had been successful. (meaning change)

(4) The cowboys and I traveled the length and breadth of the great mesa, but our prey always avoided us. (distractor)

The sentences above are used in a task which involves having the student read a twelve sentence segment of text, and then rating 16 test sentences (4 original, 4 paraphrase, etc.) as being "old" or "new." The readers are instructed to rate a sentence old if it is the same as or means the same as an originally appearing sentence; otherwise the sentence is to be rated new. After scoring, the data is submitted to signal detection analysis (e.g., Coombs, Dawes, & Tversky, 1970) to separate response bias from response accuracy.

Preliminary data from studies using Royer's technique appears promising in that the technique seems to yield reliable results, is sensitive to varying difficulty in reading materials, and is highly correlated to standardized reading comprehension test performance but is less highly correlated with IQ measures than are standardized tests. This may mean that the technique is less sensitive to variability in reasoning ability than are standardized tests.

Another feature of the sentence verification procedure is its possibilities as a diagnostic technique. For example, a reader who was overly reliant on a word by word analysis of text might be expected to respond "old" to original sentences (correctly) and meaning change sentences (incorrectly), and to respond"new" to paraphrases (incorrectly) and distractors (correctly). In a similar fashion, a reader who was overly reliant on higher level

processing--a "top-down" processor, to use Rumelhart's (1977) phrase--might respond "old" to original sentences, paraphrases, and distractors (since all of these are semantically consistent with the theme of the passage) and respond "new" to meaning changes (since these frequently violate the gist of the passage). Other patterns of responding might be signals for other sorts of reading difficulties.

A third technique for measuring reading comprehension which appears promising would involve both listening and reading (see Carroll, 1977, for arguments about combined listening/reading tests). One possibility would be to read a sentence and then have the examinees select a sentence from among several alternatives (Royer's paraphrase, original, meaning change, and distraction sentences might provide items for a response set) which meant the same thing as the sentence which was heard. A variant of this procedure could be used to measure both listening and reading comprehension simultaneously. This could be done by having the student listen to a sentence, and then selecting both a picture and a sentence which meant the same thing as the sentence which was heard.

The techniques described above have a number of shortcomings. For example, Carroll (1971) has mentioned several difficulties with the picture matching procedure which would limit its use. These include problems with guessing, the fact that only certain materials lend themselves to pictorial representation, difficulty in preparing appropriate pictorial materials, and the fact that a picture cannot capture all the lexical and grammatical material that a sentence might contain. These difficulties vary in importance. The problem with only some material lending itself to pictorial

representation clearly limits the use of the technique to certain situations. Other problems, however, are not so important. On most occasions it would not be necessary to capture all of the grammatical and lexical nuances of a verbal message in a picture. In addition, the guessing problem is critical only if one wants to assess the comprehension of a given verbal message with only one or two test items.

A possible limitation of Royer's technique, and for that matter, the other techniques under discussion, is that it is most applicable to single sentences responding. It may be possible to expand the technique to more than single sentence units, but, thus far, such an attempt has not been made.

The listening/reading techniques suffer from the same limitations previously mentioned for the picture and sentence verification tasks. That is, it is not possible to develop pictures which are comparable in meaning to all types of text, and the techniques are probably limited to single sentence units.

The techniques for measuring comprehension discussed in the section above would have the most utility when the tests were being used for evaluative purposes. The techniques are likely to be less useful when the tests are to be used for diagnostic purposes. The ideal diagnostic instrument would be based on a developmental theory of the comprehension process. That is, one would like to know when certain processes and cognitive structures normatively appear, the sequence in which they appear, and the sorts of experiences which lead to their appearance. We are obviously a long way from having such a theory, but the beginnings of a theory seem to be emerging

from recent work on prose comprehension in children (see Stein, in press, for a review of this literature).

In this section of the paper we have argued that a reading comprehension test to be used for evaluative purposes would ideally be sensitive to the form of memory representation and would be insensitive to differences in prior knowledge and reasoning ability. We want to make clear that we do not believe that prior knowledge and reasoning ability can be eliminated entirely as sources of variability in reading comprehension testing. For example, it is surely the case that extent of prior knowledge is going to influence the degree of comprehension. This becomes a factor in comprehension testing since two individuals who have been judged to be familiar with the topical content of a passage may still vary in their extent of familiarity, and this in turn may influence their test performance.

In a similar fashion, it is likely to be the case that inferential processses are an automatic part of the reading process (Rumelhart, 1977; Schank & Abelson, 1977), and that it is nonsensical to suggest totally removing inferencing from comprehension testing. What one can do, however, is remove items which require the conscious search of existing memory and the integration of the results of that search with something which has recently been read. These sorts of items surely lend weight to general ability factors, and detract from the measurement of reading comprehension, per se.

Summary and Conclusions

Several years ago Simmons (1971) surveyed the comprehension testing literature and identified seven approaches which have been employed in

defining and measuring reading comprehension (i.e., skills, measurement, factor analytic, correlational, readability, introspective, and models). Of these approaches, it is probably safe to say that the theoretical model approach has had the least practical impact. One purpose of this paper was to attempt to show that comprehension theory can make some contribution to the measurement of reading comprehension.

We have argued that there is a theoretical principle which must be part of any serious theory of reading comprhension. This principle, which we called the minimal comprehension principle, asserts that the act of comprehension must entail an interaction between an incoming linguistic message and the reader's world knowledge.

An analysis of current tests of reading comprehension indicated that the text passages are likely to draw broadly from knowledge of the world. This feature, when combined with implications from the minimal comprehension principle, leads to the conclusion that some of the variability in reading comprehension test performance is attributable to differences in prior knowledge, rather than differences in reading skills, per se. This conclusion leads to a further conclusion; namely, that failure on a test of comprehension could be attributable to lack of prior knowledge needed to interpret a text message, or to lack of reading skills. Most tests of reading comprehension currently in use do not allow one to distinguish between these two reasons for failure.

The inability of a test to distinguish between failure due to lack of critical prior knowledge, and failure due to lack of reading skills, has little bearing on the utility of the test as a predictive instrument. However,

this feature greatly restricts the use of the test in situations where one wants to either diagnose reading difficulties or assess educational gain. In fact, one conclusion drawn from the implications of the minimal comprehension principle is that reading comprehension tests currently in use may be insensitive to gains in reading skills among disadvantaged segments of our population.

Having argued that performance on current tests of reading comprehension was influenced by variability in prior knowledge and reasoning ability, we went on to suggest that an optimal test for the purposes of diagnostics and evaluation would reduce these sources of variability to a minimum. This could be done by matching prior knowledge to the topical content of test passages, and by using assessment techniques which are relatively insensitive to differences in reasoning and inferential ability.

Many of the suggestions we have made in this article should be subject to empirical verification. While we believe there is ample evidence supporting the minimal comprehension principle, there is not evidence that extent of prior knowledge makes an independent contribution to performance on reading comprehension tests. Experiments should be conducted to test this possibility. If it were determined that there was an effect for prior knowledge, further research, along the lines suggested in this paper, would be needed to determine if those effects could be reduced.

And finally, research is also needed on the issue of whether reasoning ability can be reduced as a source of variability in reading comprehension test performance. We have suggested several techniques for assessing

comprehension which should be less responsive to differences in reasoning ability, but research is needed to establish if this is so.

Reference Notes

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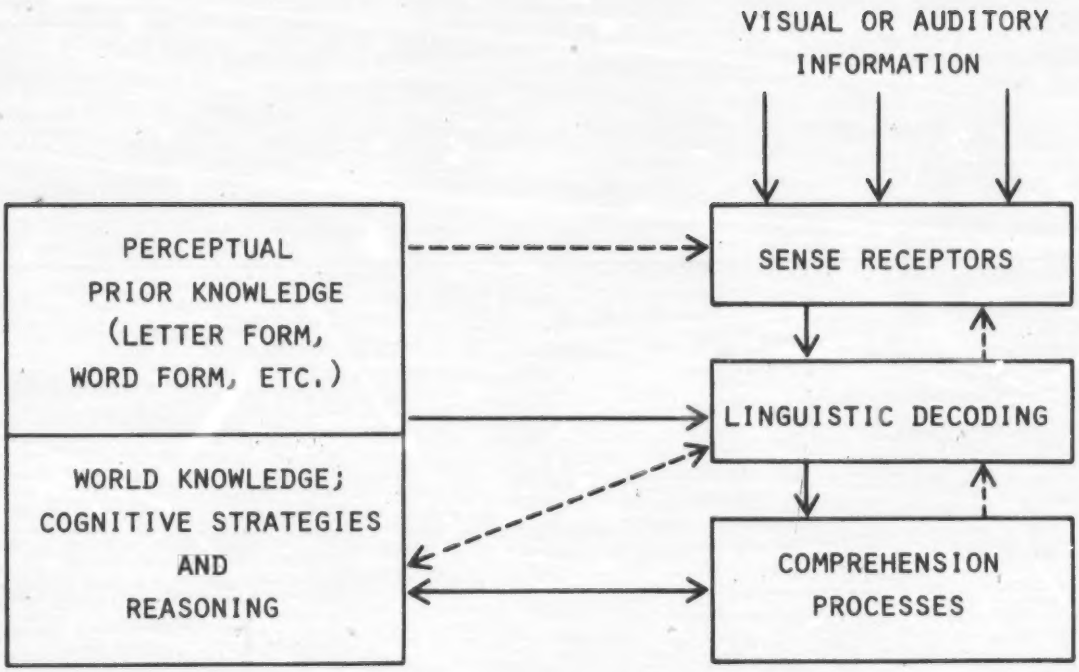
Figure Caption

Figure 1. A framework for viewing the comprehension process.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